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Status of Aqua MODIS On-orbit Calibration and Characterization

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ABSTRACT

The MODIS Flight Model 1 (FM1) has been in operation for more than two years since its launch onboard the NASA's Earth Observing System (EOS) Aqua spacecraft on May 4, 2002. The MODIS has 36 spectral bands: 20 reflective solar bands (RSB) with center wavelengths from 0.41 to 2.2 μ m and 16 thermal emissive bands (TEB) from 3.7 to 14.5 μ m. It provides the science community observations (data products) of the Earth's land, oceans, and atmosphere for a broad range of applications. Its primary on-orbit calibration and characterization activities are performed using a solar diffuser (SD) and a solar diffuser stability monitor (SDSM) system for the RSB and a blackbody for the TEB. Another on-board calibrator (OBC) known as the spectro-radiometric calibration assembly (SRCA) is used for the instrument's spatial (TEB and RSB) and spectral (RSB only) characterization. We present in this paper the status of Aqua MODIS calibration and characterization during its first two years of on-orbit operation. Discussions will be focused on the calibration activities executed on-orbit in order to maintain and enhance the instrument's performance and the quality of its Level 1B (L1B) data products. We also provide comparisons between Aqua MODIS and Terra MODIS (launched in December, 1999), including their similarity and difference in response trending and optics degradation. Existing data and results show that Aqua MODIS bands 8 (0.412 μ m) and 9 (0.443 μ m) have much smaller degradation than Terra MODIS bands 8 and 9. The most noticeable feature shown in the RSB trending is that the mirror side differences in Aqua MODIS are extremely small and stable (<0.1%) while the Terra MODIS RSB trending has shown significant mirror side difference and wavelength dependent degradation. The overall stability of the Aqua MODIS TEB is also better than that of the Terra MODIS during their first two years of on-orbit operation.

Keywords: Aqua, Terra, MODIS, solar diffuser, SRCA, blackbody, calibration, radiometry, uncertainty

1. INTRODUCTION

Two nearly identical copies of the Moderate Resolution Imaging Spectroradiometer (MODIS), the Protoplatform Model (PFM) and the Flight Model 1 (FM1), were designed and built by Raytheon/Santa Barbara Remote Sensing (SBRS) for the NASA's Earth Observing System (EOS) missions¹⁻³. The MODIS instrument was designed and developed based on the desire of the science community to improve and extend existing (heritage) sensors' capabilities in terms of spectral (band and bandwidth) coverage, spatial resolutions, and temporal scales. It has 36 spectral bands with wavelengths from 0.41 to 14.5 μ m. It makes measurements at three different nadir spatial resolutions: 250m for bands 1-2 (40 detectors/band), 500m for bands 3-7 (20 detectors/band), and 1000m for bands 8-36 (10 detectors/band). Bands 1-19, and 26 are the reflective solar bands (RSB) and the others are the thermal emissive bands (TEB). The 36 spectral bands are distributed, according to their wavelengths, on four focal plane assemblies (FPAs): visible (VIS), near infrared (NIR), short- and mid-wave infrared (SMIR), and long-wave infrared (LWIR). MODIS is a passive cross-track scanning radiometer with a wide field-of-view (FOV) of $\pm 55^\circ$ about instrument nadir and uses a double-sided paddle wheel scan mirror that rotates at 20.3 rpm. At a nominal orbiting altitude of 705km, each scan of 1.478 seconds produces a swath of 10km (nadir) in the along track direction and 2330km in the along scan direction, resulting in near-global coverage of the Earth every 2 days.